--59. (new) The method as claimed in claim 58, wherein the copper-diffusion stopper insulating film comprises one of $Si_3N_4$ film and SiON film.

--60. (new) The method as claimed in claim 18, wherein said step of carrying out an anti-corrosion treatment comprises flowing the anti-corrosive agent onto the surface of the semiconductor substrate.

B13 and

--61. (new) The method as claimed in claim 60, wherein said step of forming a copper-diffusion stopper insulating film comprises forming the copper-diffusion stopper insulating film by chemical vapor deposition.

--62. (new) The method as claimed in claim 61, wherein the copper-diffusion stopper insulating film comprises one of $Si_3N_4$ film and SiON film.--

REMARKS

Claims 1-33 were previously pending in the application. New claims 57-62 are added. Therefore, claims 1-33 and 57-62 are presented for consideration.

Claims 1-7, 16, 18-23 and 32 are rejected as anticipated by OBENG et al. 6,323,131. This rejection is respectfully traversed.

Independent claims 1 and 18 recite carrying out an anti-corrosion treatment by exposing a surface of a semiconductor substrate to a solution containing an anti-corrosive agent, and

subsequently, separately forming a copper-diffusion stopper insulating film over the surface of the semiconductor substrate.

By way of example, page 15, lines 16-23 of the present application, disclose that an anti-corrosion treatment is carried out by exposing the surface of the semiconductor wafer to a solution containing an anti-corrosive agent thereby to form an anti-corrosive film before a copper-diffusion stopper insulating film is formed over the surface of the semiconductor substrate. Accordingly, a first film, the anti-corrosive film, is formed and subsequently a separate second film, the copper-diffusion stopper insulating film, is then formed.

In contrast, column 2, lines 51-61 of OBENG et al., for example, disclose forming a single film that is an anti-corrosive film that acts as a barrier layer to prevent the diffusion of copper ions. Accordingly, OBENG et al. teach a single step process of forming only one film. This one film protects the surface of the copper from atmospheric corrosion and also provides a temporary barrier layer between the substrate and the copper interconnects to prevent migration of copper ions into the substrate. OBENG et al. do not disclose forming two separate films by carrying out an anti-corrosion treatment by exposing a surface of a semiconductor substrate to a solution containing anti-corrosive agent, and separately forming a copper-diffusion stopper insulating film, as recited in claims 1 and 18.

Accordingly, claims 1 and 18 are believed patentable over the cited prior art.

Claims 2-7 and 16 and 19-23 and 32 depend from claims 1 and 18, respectively. For the reasons set forth above regarding claims 1 and 18, claims 2-7, 16, 19-23 and 32 are believed patentable over the cited prior art.

In addition, claim 4 recites that the anti-corrosion treatment is carried out subsequently to a cleaning process with a cleaning solution and claim 5 recites that the cleaning solution comprises a carboxylic acid based cleaning solution.

OBENG et al. at column 2, lines 62-63, for example, disclose that the anti-corrosive passivating film applied in a single step anti-corrosion treatment is comprised of carboxylic acid. There is no teaching or disclosure in OBENG et al. of a cleaning process with a cleaning solution that comprises a carboxylic acid based cleaning solution and a subsequent step of anti-corrosion treatment as recited in claims 4 and 5.

Claim 16 recites that the copper-diffusion stopper insulating film comprises an $Si_3N_4$ film. Although column 1, lines 33-53 of OBENG et al. teach forming an $Si_3N_4$ film, this teaching is in the background of the invention as an alternative to forming the anti-corrosion passivating film. Specifically, column 1, lines 46-51 of OBENG et al. state that it would be advantageous to find a less costly and/or less time consuming passivation process which preferably can be done in a single step

without the need for specialized expensive capital equipment and which does not employ harsh processing parameters. OBENG et al. further state that it is also desirable to find alternative barrier materials and processes to prevent migration of copper into the underlying substrate.

Accordingly, OBENG et al. disclose forming an $Si_3N_4$ film as an alternate barrier material to the anti-corrosive film. There is no disclosure or suggestion of forming both an anti-corrosive passivating film and a second material as a barrier layer/copper-diffusion stopper. There is similarly no disclosure that the copper-diffusion stopper insulating film comprises an $Si_3N_4$ film, as specifically recited in claim 16.

Claims 17 and 33 are rejected as unpatentable over OBENG et al. This rejection is respectfully traversed.

As stated above regarding claims 1 and 18, OBENG et al. do not disclose the method steps of carrying out an anti-corrosion treatment by exposing a surface of a semiconductor substrate to a solution containing anti-corrosive agent, and separately forming a copper-diffusion stopper insulating film. Additionally, this reference no more teaches or suggests these features than it does explicitly disclose the same. Furthermore, OBENG et al. specifically teach away from using a two-step process of forming an anti-corrosion layer and a copper diffusion barrier.

Since claims 17 and 33 depend from claims 1 and 18, respectively, and further define the invention, for the reasons set forth above regarding claims 1 and 18, claims 17 and 33 are believed patentable over the cited prior art.

In addition, one having ordinary skill in the art would not be motivated to substitute the $SiO_2$ insulating layer of OBENG et al. with an SiON copper-diffusion stopper insulating material as suggested in the Official Action. The $SiO_2$ and SiON are not interchangeable materials. As taught at column 1, lines 33-38 of OBENG et al., the silicide coating (SiON) is used to avoid the copper interaction with $SiO_2$. Accordingly, the two materials are different and one having ordinary skill in the art would not substitute one for the other.

Claims 8-15 and 24-31 are rejected as unpatentable over OBENG et al. in view of LAWSON 4,978,756. This rejection is respectfully traversed.

LAWSON is cited for the teaching of hetero-cyclic compounds and derivatives thereof and aromatic compounds. LAWSON does not teach or suggest carrying out an anti-corrosion treatment and subsequently, separately forming a copper-diffusion stopper insulating film as recited in claims 1 and 18. As stated above, OBENG et al. do not teach or suggest what is recited in claims 1 and 18. Since claims 8-15 and 24-31 depend from claims 1 and 18, respectively, for the reasons set forth above regarding

claims 1 and 18, claims 8-15 and 24-31 are believed patentable over the cited prior art.

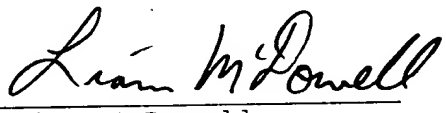
New claims 57-62 depend from one of claims 1 and 18 and have support on page 30, lines 18-23 and page 32, lines 10-19.

In view of the present amendment and the foregoing remarks, it is believed that the present application has been placed in condition for allowance. Reconsideration and allowance are respectfully requested.

Attached hereto is a marked-up version showing the changes made to the specification and claims. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

Respectfully submitted,

YOUNG & THOMPSON

By 

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May 28, 2002

**"VERSION WITH MARKINGS TO SHOW CHANGES MADE"**

IN THE SPECIFICATION:

Page 3, the paragraph, beginning on line 11, has been amended as follows:

--In accordance with the above conventional processes, the semiconductor wafer 1 is exposed to an air or an atmosphere after the semiconductor wafer 1 is unloaded from the cleaning apparatus and before the semiconductor wafer 1 is loaded into the growth chamber. A time duration between after the semiconductor wafer 1 is unloaded from the cleaning apparatus and before the semiconductor wafer 1 is loaded into the growth chamber depends upon a waiting time for loading the semiconductor wafer into the growth chamber. The waiting time may be, actually, for example, one day or more.--.

Page 5, the paragraph, beginning on line 10, has been amended as follows:

--It is a further object of the present invention to provide a novel method of treating a semiconductor wafer surface suppressing oxidation of a copper-region of the surface thereof even if the semiconductor wafer is exposed to the atmosphere.--;

the paragraph, beginning on line 24, bridging pages 5 and 6, has been amended as follows:

--It is a further object of the present invention to provide a novel method of forming a semiconductor device

suppressing oxidation of a copper-region of the surface thereof even if the semiconductor wafer is exposed to the atmosphere.--.

Page 10, the paragraph, beginning on line 24, bridging pages 10 and 11, has been amended as follows:

--It is necessary to prevent the above formations of the CuOx film and the hillock, even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. Namely, it is necessary to prevent any oxidation of the copper region or the copper interconnection surface on the semiconductor wafer surface even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface.--.

Page 11, the paragraph, beginning on line 8, has been amended as follows:

--In accordance with the present invention, an anti-corrosion treatment is carried out by exposing the surface of the semiconductor wafer to a solution containing an anti-corrosive agent thereby to form an anti-corrosive film before a copper-diffusion stopper insulating film is then formed over the surface of the semiconductor substrate, so that the anti-corrosive film prevents the semiconductor wafer surface from any oxidation during when the semiconductor wafer surface is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. As a result, it is

possible to prevent the above formations of the CuOx film and the hillock, even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. Namely, it is possible to prevent any oxidation of the copper region or the copper interconnection surface on the semiconductor wafer surface even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface.--.

Page 15, the paragraph, beginning on line 16, bridging pages 15 and 16, has been amended as follows:

--In accordance with the present invention, an anti-corrosion treatment is carried out by exposing the surface of the semiconductor wafer to a solution containing an anti-corrosive agent thereby to form an anti-corrosive film before a copper-diffusion stopper insulating film is then formed over the surface of the semiconductor substrate, so that the anti-corrosive film prevents the semiconductor wafer surface from any oxidation during when the semiconductor wafer surface is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. As a result, it is possible to prevent the above formations of the CuOx film and the hillock, even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. Namely, it is

possible to prevent any oxidation of the copper region or the copper interconnection surface on the semiconductor wafer surface even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface.--.

Page 20, the paragraph, beginning on line 3, has been amended as follows:

--In accordance with the present invention, an anti-corrosion treatment is carried out by exposing the surface of the semiconductor wafer to a solution containing an anti-corrosive agent thereby to form an anti-corrosive film before a copper-diffusion stopper insulating film is then formed over the surface of the semiconductor substrate, so that the anti-corrosive film prevents the semiconductor wafer surface from any oxidation during when the semiconductor wafer surface is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. As a result, it is possible to prevent the above formations of the CuOx film and the hillock, even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. Namely, it is possible to prevent any oxidation of the copper region or the copper interconnection surface on the semiconductor wafer surface even if the semiconductor wafer is exposed to the atmosphere

before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface.--.

Page 24, the paragraph, beginning on line 20, bridging pages 24 and 25, has been amended as follows:

--In accordance with the present invention, an anti-corrosion treatment is carried out by exposing the surface of the semiconductor wafer to a solution containing an anti-corrosive agent thereby to form an anti-corrosive film before a copper-diffusion stopper insulating film is then formed over the surface of the semiconductor substrate, so that the anti-corrosive film prevents the semiconductor wafer surface from any oxidation during when the semiconductor wafer surface is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. As a result, it is possible to prevent the above formations of the CuOx film and the hillock, even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. Namely, it is possible to prevent any oxidation of the copper region or the copper interconnection surface on the semiconductor wafer surface even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface.--.

Page 30, the paragraph, beginning on line 18, has been amended as follows:

--In accordance with the present invention, the anti-corrosion treatment is carried out by use of the anti-corrosive solution containing 1% of benzotriazole. The semiconductor wafer is rotated [with receipt of] while receiving a supply [the] of benzotriazole containing anti-corrosive solution at a flow rate of 1 liter per one minute for 10 seconds to form the anti-corrosive film on the surface of the semiconductor wafer 1.--.

Page 48, the paragraph, beginning on line 10, bridging pages 48 and 49, has been amended as follows:

--In accordance with the present invention, an anti-corrosion treatment is carried out by exposing the surface of the semiconductor wafer to a solution containing an anti-corrosive agent thereby to form an anti-corrosive film before a copper-diffusion stopper insulating film is then formed over the surface of the semiconductor substrate, so that the anti-corrosive film prevents the semiconductor wafer surface from any oxidation during when the semiconductor wafer surface is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. As a result, it is possible to prevent the above formations of the CuOx film and the hillock, even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface. Namely, it is possible to prevent any oxidation of the copper region or the copper interconnection surface on the semiconductor wafer surface

even if the semiconductor wafer is exposed to the atmosphere before the copper diffusion stopper insulating film is formed over the semiconductor wafer surface.--.

IN THE CLAIMS:

Claim 1 has been amended as follows:

--1. (amended) A method of treating a surface of a semiconductor substrate, said surface of said semiconductor substrate including at least any one of a copper region, a copper based region and a copper alloy region, said method comprising the steps of:

carrying out an anti-corrosion treatment by exposing said surface of said semiconductor substrate to a solution containing an anti-corrosive agent; and

subsequently, separately forming a copper-diffusion stopper insulating film over said surface of said semiconductor substrate.--

Claim 18 has been amended as follows:

--18. (amended) A method of forming a semiconductor substrate having at least an interconnection made of a metal selected from the group consisting of copper, copper-based materials, and copper alloys, said method comprising the steps of:

carrying out a chemical mechanical polishing process for forming said at least interconnection in at least a groove in said semiconductor substrate;

carrying out an anti-corrosion treatment by exposing a surface of said semiconductor substrate to a solution containing an anti-corrosive agent; and

subsequently, separately forming a copper-diffusion stopper insulating film over said surface of said semiconductor substrate.--